A Few Genral Remarks on the Germ Theory and its relation to the Germ Theory of disease.

Numerous experiments have of late years been made with a view to discover the nature and origin of Germs, but those who have laboured in this field of research have unfortunately not been able to come to the same conclusions, and on that account have resolved themselves into two parties - Biogenists and Abiogenists. Biogenists or the germ theorists have men such as M. Pasteur Dr Tyndall and Professor Lister amongst them, while, on the other hand, the Abiogenists or the advocates of spontaneous generation can boast of such men as Bastian, Burdon-Sanderson, Cohn, Hutzinga, &c.,

Although Dr Tyndall has in a

letter to the Royal Society of London not very long ago, been sanguine enough to state that the question of spontaneous generation is practically settled, yet it is to be feared the evidence on the other side cannot be satisfactorily explained by the germ theory as it stands at present.

By careful examination of each set of series of experiments, it can easily be observed that the experimentalist starts with a preconceived notion of what he would like the result to be, and carries it on in such a way as best calculated to secure a triumph for his party*. Far be it from me to to entertain the idea that party strife can in any way interfere with the veracity of the experiments as related by the experimentalist, & do admit that there is

* Would a learned statesman by any means once think of such a matter here?

a possibility of the interpretation of them (if I may so call it) being one-sided. The experiments are however of very great importance because they enable those who have neither the time, nor the means, at their command to judge for themselves, and arrive at their own conclusions. Given the full details of a series of experiments, and knowing that they are performed by able and trustworthy men in such a way as none but experts possessed of ample time, apparatus, &c. could conduct them, we are able to argue out conclusions from a neutral point of view.

The details of some of the most important series of experiments may now be given, as examples.

In 1845 at the Royal Institution, London, Dr Tyndall prepared infusions

and used cotton plugs to prevent the entrance of germs. The result was that the infusions remained sterile. In 1876, he repeated the same experiments and found that the infusions fructified. This he accounted for by saying, that there being old hay in the Institution in 1876, there were too many germs in the air and that some must have worked their way through the cotton plugs. He again carried on the same experiments "in the pure air of Kew" and succeeded in keeping all the infusions sterile except one which became turbid. This exceptional tube was found to have a pin-hole perforation in the bottom of it, which probably afforded entrance for germs.

The above proof that where the air is foul there are germs in abundance and where it is pure

that there are not so many. Evidently, Dr Tyndall looked upon the old hay as the source from which the additional germs arose. The cotton plug is not effectual against the ingress of germs except when they are comparatively few in the surrounding medium!

In Lancet 5th Dec. 1877.

Dr Tyndall produced strong evidence of the influence of impure air in the development of Bacteria by the following experiments. Of fifty flasks containing various organic infusions after having been sterilized by boiling, twenty-three were opened in a hay loft, and the remaining twenty-seven (with special precautions that the air should be uncontaminated by his own presence) on the edge of an Alpine cliff. Both were then placed in a warm room with the result that twenty one of the

twenty three flasks opened in the hay loft became speedily filled with organisms, whilst all the flasks opened on the edge of the precipice remained clear.

Nineteenth Century" Jany. 1878.

Dr Tyndall relates another series of experiments where he placed organic infusions into moteless chambers and at any heat varied according to the "Caprice" of his opponents, it remained clear while upon the chambers being opened they at once turned turbid. This latter was evidently arranged to disprove the doctrine of Spontaneous Generation.

The inference drawn from these experiments is, that fluid infusions in which there are no living organisms to begin with, remain sterile under the most favourable conditions for the development of life, provided always that no germs can enter from without. But, that if germs

be allowed to enter fructification is sure to be the result.

The general conclusion is that, "organic matter has no inherent power of generating Bacteria and no inherent power of passing into decomposition" but that if the smallest amount of germ bearing air or water, be admitted decomposition will at once set in - Dr Tyndall holds that dead organic matter cannot produce fermentation, and argues that it is on account of the death point of some Bacteria being very high that the advocates of Spontaneous generation have a leg to stand upon, at all, and instances the plant medicago which will survive four hours boiling. Dr Tyndall's real germ, however, is ultra-microscopical and behaves differently from all known visible particles

when heated,
to heat. This is the germ that contaminates infusions.

Again the following may be given as examples of experiments carried on by the advocates of Spontaneous generation - Bastian carried on a series of experiments in which he found that various infusions behaved variously, though treated similarly. that solutions which remained sterile at one temperature, fructified at another, and that neutrality or a degree of acidity or alkalinity of infusions had the greatest bearing on the results obtained. Burdon-Sanderson repeated the same experiments with Bastian and found the same results. Pasteur who may be styled the leader of the opposition party concurs with Bastian in the experiments in which boiled liquor Potassae added to previously

boiled urine and the mixture kept at the temperature of 122°F, resulted in the development of Bacteria in great abundance after a short time. Colin found that hay infusions putrified when acid after boiling for periods of from 15 to 60 minutes.

Pasteur Lancet 2th May 1877.

Experiments prove that a temperature of 100°C will kill germs in acid urine, but that it requires a much higher temperature to kill them in alkaline urine.

Bastian carried on a set of experiments in which he boiled acid urine until all the germs must have been killed and then he added boiled liquor Potassae to neutralization but the liquid soon afterward became turbid.

Bastian holds that germs are killed by a temperature at the outside of 158°F, in turnip and

other infusions - These infusions remain clear when protected, but putrefy at once on the addition of a putrifying fluid. Sometimes infusions treated identically in the same way do not remain clear.

The conclusions arrived at by Heterogenists, and based upon experiments such as the above are, that organic infusions in which all living organisms were killed by boiling, produced spontaneously at a suitable temperature, in other words, that whenever organic matter is placed under favourable circumstances, life will spontaneously appear.

Strong as the latter class of experiments are in favour of the above mentioned conclusions, they are far from being proven to the satisfaction of all, and seeing

that they are at variance with all previous conception of life, they require undoubted proof.

Spontaneous generation, and the evolution theory, being admitted, life in all its forms may be accounted for scientifically.

Remarks.— The Advocates of Spontaneous Generation have almost unsurmountable difficulties to contend with in clearing up all sources of doubt.

1. Life as it presents itself to us both in the animal and vegetable Kingdoms, does not either directly, or by analogy, warrant their conclusions.

2. It must be very questionable if all organisms contained in the infusions are killed as they are supposed to be by boiling. It is the lowest forms of life that they have to deal with, and it is a well-known fact that as we descend the scale the tenacity

of life becomes more marked in the individual. Where the animal kingdom meets the vegetable (Regnum Protisticum of Haeckel) - where we are obliged to call the individual a Zoophyte, from its showing partly the nature of a plant, and partly the nature of an animal. an organism may be divided into any number of parts, and each portion will become an independent being. It is said of the Rotifera, which are not at all the simplest forms of life, that they may be dried, pounded to dust, and laid aside for a number of years, and still that the addition of a little water will restore them to their former activity at any time.

But all animals, and the whole or part of all plants, are made up of cells which contain protoplasm, and each of these more particularly

the animal cells, when freed should show all the essential properties of protoplasm viz. Assimilation, movements and multiplication. It is highly probable, that nothing short of a molecular change can deprive these of the life they possess, in other words, that protoplasm as such cannot be divested of its properties, when under favourable conditions, although it may lie dormant like the dried dust of the Rotifera under adverse surroundings.

3. That they carry on their experiments with organic infusions is objectionable on the ground that it may possibly be a fertile source of error. It is true that the elements must be present before we can expect a body composed of such elements to appear, but as long as organic matter is used in experiments for the support of this theory, they can never prove that

life can spring up de novo, simply because without organisms (or life which is the essence of all organisms) we could never have organic matter.

4. Life and its agency being so widely diffused, it must be almost impossible to exclude organic matter and at the same time expose the infusions to circumstances favourable to life.

The sum and substance of their theory may briefly be represented as follows. viz. They begin with an infusion in which there is life, then put it through a process which is supposed to kill all the living organisms present, and lastly exclude all germs, and simply because signs of life appear they conclude that life may appear spontaneously.

On the other hand the germ theorists have gone to the other extreme in forming their conclusions, for they

holds that organic matter has no inherent power of passing into decomposition. But that if the smallest quantity of germ-bearing air be admitted decomposition will at once set in. This is contrary to the experience of Liebig who said that "dead decaying matter can produce fermentation."

After a little reflection we see clearly how Dr Tyndall managed to obtain negative results. In boiling the infusions he probably did it so thoroughly that there was not a particle of protoplasm left unaltered, and the cotton wool plugs proved effectual barriers against the entrance of organic particles.

One would be inclined to doubt that cotton plugs allow of free communication between the air in the flask and the surrounding air.

for that, lodged in the crevices of the cotton wool is likely retained there by capillary attraction, and moves only to the extent necessary to establish equilibrium between the air in the flask, and the external air. The same may be said of narrow Jeg. Jas tubes. That evaporation takes place can hardly be a proof that the air gets free admission, and to make sure ~~there~~ each flask should be furnished with two apertures plugged with cotton wool, and suction practised at one or other of the apertures periodically.

The fact that air can be filtered of its germs goes a great length to prove that they are not an essential part of it, but some accidental impurities of which it may be purified.

It will be quite early enough to ~~[illegible]~~ accept the theory that Bacteria owe their origin to ultra microscopical germs when they cannot be accounted for in a more satisfactory manner.

The following conclusions which I think are quite consistent with what is as yet known on the subject, and which, though not proven, have the advantage of being more satisfactory and less shrouded with mystery than those which refer germs to extra-terrestrial origin, have forced themselves upon me in summing up what I have read on the subject. viz.

1. That it is possible that cell-life continues after the death of the organism and that as long as the molecular constitution of each cell, or part of one, remains unaltered

it will show all the essential properties of protoplasm at any time if placed under favourable circumstances.

2. That it is these particles of organic matter that excite decomposition, and that are the real germs.

3. That decomposition is the process by which the army of germs recruit their numbers.

4. That when particles of organic matter alight upon fresh organic matter, they find it a suitable soil, and begin to assimilate nourishment from it, and multiply, but that in course of time, living particles are liberated from the fresh organic matter. and there being two or more species of germs present, a sort of struggle for existence takes place and fermentation or decomposition is the result.

That the air is loaded with organic particles can easily be demonstrated by allowing a narrow streak of sun beam to enter a darkened room, when it will appear like a rod. If red-hot iron be then placed near it the rod breaks because the heat burns the suspended organic particles in the area around it.

That germs prove more active where the air is loaded with organic particles and that exposed wounds do better in well-ventilated wards than in ill-ventilated and over-crowded ones, suggest the idea that germs and organic particles are one and the same. I think this is brought out clearly by Dr Tyndall's experiments. Where old hay was present the ordinary means failed to exclude them, and even at Kew where he called the air "pure" the only flask in which there was a flaw

fructified, but on the top of the Alpine cliff, tho, the infusions were freely exposed, and the temperature adjusted, there was no attempt at fructification. This may be accounted for by the fact that the infusions being so thoroughly boiled there was no organic matter present, the boiling having altered it constitutionally. M. Pasteur says that Bacteria are "aerobic" in their habits, that is that they absorb oxygen and exhale carbon dioxide, and all experience goes to prove that air is essential to organic life in a state of activity and growth, and it is singular that the germs or vibrios of putrifaction should be exceptions; indeed there is reason to believe that it is only a supposition because he loses sight of it, in his explanation of the fact that the Bacillus Anthrax cannot live in the presence of the germs of

x by which they are robbed of their oxygen.

putrifaction. It is said that some fungi also, exhale oxygen and inhale carbonic acid gas.

Germs do not confine themselves to decomposition, but they also attack living tissues. When an open sore is exposed they settle down upon it and ~~it~~ set up a species of fermentation resulting in a copious discharge of pus. The triumphant success of the surgery of the present day is to be attributed to the exclusion of germ-bearing air, by the antiseptic mode of dressing. Those who are stiff-necked enough to stand back and reject Mr. Listers mode of dressing, are by additional sanitary precautions, acting upon an antiseptic treatment more or less complete; indeed the improved state of our hospitals

may be said to be founded upon the germ theory.

Many diseases such as infantile diarrhoea, English cholera, Dysentery, Influenza, &c. &c. can be traced to germ-bearing air and water.

It is enough for one to know that he inhales at each 30 cb. inches of air at each inspiration to impress him with the fact that it is to his advantage to have pure air to breathe. The air itself independent of any impurities must be a productive source of disease. The ever-varying temperature and humidity of the air, especially when changes are sudden, are sure to be a source of great mischief, and a frequent cause of pulmonary, renal, and cutaneous diseases. Foreign particles floating about in the air we breathe, whether of gaseous, liquid,

or solid consistence, are sure to depress the health, and even predispose to disease, and the mischief probably is not only proportional to their aggregate bulk, but also depends upon their qualities. Thus we see that they act in a two-fold manner, (1) they may be injurious in themselves, (2) they deteriorate the quality of the air. Nay, we could safely stretch another point, and say that the mischief is also proportional to the length of time one is exposed to such air. The rationale of this point is, that though the germs (Fomes Particles) may not be injurious to the healthy, because the living principle is so strong that the inroads of germs have no effect, yet, if the exposure

be too long, the health may be so much depressed ~~that~~ from the want of oxygen, that the vital living principle will not be strong enough to resist them.

Having dwelt at such length upon the germs of decomposition, a few remarks upon their agency in the blood, as we see it in septicaemia may not be devoid of interest.

Septicaemia results either from the free exposure of a raw surface to the poison, or from the poison generating in the wound itself, and it is necessary that septic germs, or their products (albuminoid "pyrogen" of Burdon Sanderson) should enter the blood current in order that the disease shd appear. This is proven by the fact that the poison may

lie on the wound, and may even infect another, and ~~yet~~ the patient may escape. It is supposed that the mode of action is as follows viz. that the septic poison paralyze the white corpuscles of the blood and causes them to part with their ferment, that this ferment gives the blood a tendency to coagulate in the capillaries (sometimes extra-vascular coagulation is met with), that the tendency to coagulation leads to congestion, stasis, exudation in the capillaries of the serous and mucous membranes, and to disintegration of the gastro-intestinal mucous membrane.

The dyspnœa, diarrhœa, and hyperæsthesia give septicæmia all the characters of a fever, and I cannot help thinking that there are many points of resemblance between

it and typhoid fever. The poison of typhoid being generated by the decomposition of ~~a ferocious stool~~ the stool of a ferocious case the fever, the Gastric ulcers, the diarrhoea &c, establish a striking resemblance between the two, and their poisons seem to be identical in many respects, e.g. 1. the two poisons are septic in their nature.

2. They produce nearly similar pathological processes.

3. There is diarrhoea in both.

If we admit that typhoid may arise de novo from filth &c. ~~the~~ (Dr Murchison's theory) the affinity is still more striking - Of course there are distinctive points of difference such as definite course, definite seats of lesion, distinctive rash, the influence of age upon the

effect of the poison in typhoid fever will at all times help to back up an easily recognizable distinction.

Germs for the sake of convenience may be divided into two kinds - Specific and non-Specific.

The non-specific, are those living units which inhabit the air of every locality - in which animal and vegetable decompositions are going on, and their injurious effects are to be combated by laws of sanitation founded upon their habits.

The specific, if we accept the doctrine of a <u>contagium vivum</u> at all, must be of great importance, as it is through their agency that we are able to account for the processes of infection and contagion.

Although the microscopist and the chemist, have failed to bring the nature of infection and contagion within the range of their discoveries, yet the doctrine of a living contagion is the most satisfactory theory hitherto brought forward, and in addition, analogy is strong in its favour. Minute living organisms were observed in the blood in malignant pustule, and relapsing fever, and similar discoveries may before long be made in some or all of the specific fevers.

That living organisms have not been found in the blood in the Specific fevers need not retard the progress of science for a moment, because it is by making ourselves acquainted with the nature and habit of each of the

infectious and contagious poisons, (whether living or dead does not signify so much that we can dispense to combat them effectually, and in this pursuit though experimental research may prove of great help, it can only take a second place to clinical observation.

To this group of diseases the old maxim that "prevention is better than cure" is peculiarly applicable, and when a man of so much skill and foresight as Sir Thomas Watson, gave it as his opinion that the abolition of Zymotic diseases in Great Britain may be witnessed by the next generation, should not every man put his shoulder to the wheel and hasten the time when

the prevention shall be so complete that cure will not be necessary? As it would be superfluous on my part to dwell upon the importance of early diagnosis, instant isolation, good ventilation, thorough disinfection, and effectual quarantine, I shall dismiss them with this bare mention.

In conclusion it may not be out of place to make a reference to the most recent arguments for and against the specificity of zymotic diseases and their propagation by living germs.

Against these may be mentioned two papers, the one by Dr Bastian on "the bearing of experimental evidence upon the germ theory of disease", the other by Dr B. W. Richardson entitled "A

Brit. Med. Journal May 12th 1878.

"Nature"
Oct. 4th 1877.

A theory as to the Natural and Glandular Origin of the Contagious Diseases

Dr Bastian in his second concluding point says "that some contagia are mere not-living chemical principles, though others may be living units" and finishes by the following peroration. viz. Thus all the distinctive positions of those who advocate a belief in the so called "germ theory of disease" or rely upon the exclusive doctrine of a contagium vivum seem to be absolutely broken down and refuted.

Dr Richardson again remarks, that "if the contagium vivum be true - if the air around us is charged with invisible germs which come from whence we know not, which have unlimited power to fertilize, which need never cease to fertilize and multiply, what hope is there for the

skill of man to overcome these hidden foes? Why on some occasion may not a plague spread over the whole world and destroy its life universally?" &c

Arguments such as the above are too finely drawn to be of practical importance, and if we study the history of medicine, we shall find that from the earliest times, mere theories however feasible they might appear to the logician, were the greatest hinderance to scientific progress. Dr Richardsons remarks are, to my mind one sided, and I shall therefore endeavour to show, that the skill of man may overcome the "hidden foes" by demonstrating how specific germs may be converted into non specific ones.

Experience shows us in typhus fever that the germs are a great

deal more active in the nascent state, so clearly was this observed that the older physicians kept a certain distance from the patient in order to be outside the radius of infection) and that when they are freely diluted with pure air they lose a great part of their virulence. When describing the mode of action of the poisons of septicaemia and typhoid fever, mention was made about the disintegration of the white corpuscles giving rise to a ferment in the blood. It is probable that every living particle thrown off the body of a typhus fever patient, has a certain amount of the typhus ferment about it when it leaves the patient, but that when it is exposed to the influence of pure air for some time, it loses its activity,

it may be through the disinfecting action of Chlorine, Iodine, Ozone &c. in the air, and becomes a simple non-specific germ. Evidently the particular ferment is the source of the disease, for we find that the patient cannot communicate the disease after the fever is entirely gone, although every particle of the patients body could infect while the fever was going on. Similar evidence may be adduced from the fact that the infective process soon stops when the body is dead. Although I look upon the ferment as the poison, I doubt if it can exist per se without the germ - it is a temporary property of the germ, a disease of it if you like.
2. For arguments in favour of the specificity of Zymotic Diseases &c. reference may be made to

Nineteenth Cent: Jany 1878

Smith: Cent: May 1877.

Brit med. Journ: Nov: 11. 1876.

a paper on Spontaneous generation by Dr. Tyndall. Another on the Zymotic diseases by Sir Thomas Watson* and Dr Roberts address in Medicine at a meeting of the British Medical Association ~~at this~~ last year a third. I think therefore that on the whole the balance of evidence, as well as the support of experience, are in favour of the supporters of the germ-theory of disease and the doctrine of a "contagium vivum"..

I hereby declare that the above Thesis has been composed by me without the aid of any other person.

John McDonald M.B.C.M.

Carbost Skye.
June 17th 1878